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Smart Parking System

[1]Sakshi Shrivastava, [2]Prashant Chakrawarti ,[3]Shawez Alam, [4]Vivek Chandran,
[5]Prof. Niketan Mishra
[1-4] Research Scholar, [5] Professor

Department of Electronics & Communication Engineering
Lakshmi Narain College of Technology & Science, Bhopal, Madhya Pradesh, India

Abstract

This project deals with an effective way of finding empty spaces and managing the number of vehicles moving in and out in complex multi storeyed parking structures by detecting a vehicle using IR sensors and thus providing a feedback. The fully automated smart car parking system is rudimental and does not require heavy lines of code nor expensive equipment. It is a simple circuit built for the exact need of purpose. This automated system is used to find the vacancy in parking spaces available and navigate the driver to reach the desired space using visuals and in an effective manner, thus reducing search time. This system is required for malls, multistorey parking structures, IT hubs and parking facilities. This makes sure the requirement of labour is insubstantial.

keywords - RFID, IOT, Arduino, Ultrasonic Sensors.

1. INTRODUCTION:

In an increasingly urbanized world, parking has become a significant challenge. Finding a parking spot can be time-consuming and frustrating for drivers, leading to traffic congestion and wasted fuel. To address this issue, smart parking systems are being developed to efficiently manage parking spaces and improve the overall parking experience.
One such solution is a Smart Parking System using Arduino. Arduino, a popular open-source electronics platform, provides a versatile and cost-effective way to build innovative projects, including smart parking systems. By integrating Arduino with various sensors and communication technologies, we can create a system that can detect the availability of parking spaces in real-time and guide drivers to vacant spots, thereby reducing congestion and enhancing convenience.

1.1 Key Components:

- **Arduino Board**: The heart of the system, Arduino serves as the central processing unit. It receives data from sensors, processes it, and controls other components accordingly.
- **Ultrasonic Sensors**: These sensors are used to detect the presence of vehicles in parking spaces. Placed strategically throughout the parking lot, they measure the distance to the nearest obstacle, enabling the system to determine if a spot is occupied or vacant.
- **LED Displays or Indicators:** LED displays or indicators are installed at the entrance of each parking lane to provide visual feedback to drivers. Green lights indicate vacant spaces, while red lights indicate occupied spaces.
- **LCD Display:** An LCD display can be integrated into the system to provide real-time information such as the total number of available parking spaces and directions to the nearest vacant spot.
- **Internet Connectivity (Optional):** For advanced functionality, such as remote monitoring and management, the system can be equipped with internet connectivity using modules like Wi-Fi or Ethernet shields.

2. WORKING PRINCIPLE:

- **Vehicle Detection:** Ultrasonic sensors are installed above each parking space to detect the presence of vehicles. When a vehicle enters or exits a spot, the sensor sends a signal to the Arduino board.
- **Data Processing**: Arduino processes the data received from the sensors to determine the occupancy status of each parking space. It updates the information in real-time and controls the LED displays accordingly.
- **Display Information:** LED displays at the entrance of each parking lane indicate the availability of spaces using green (vacant) and red (occupied) lights. Additionally, an LCD display provides overall parking status and directions to available spots.
- **Optional Features:** With internet connectivity, the system can offer additional features such as remote monitoring via a web interface or mobile app, real-time updates on parking availability, and integration with

navigation systems to guide drivers to the nearest vacant spot.

IMPORTANT-
The working of a smart parking system using Arduino involves several steps, including vehicle detection, data processing, and user interface interaction. Here's a detailed breakdown of how such a system typically operates:

Vehicle Detection- Ultrasonic sensors or other types of proximity sensors are installed above each parking space.These sensors emit ultrasonic waves and measure the time taken for the waves to bounce back after hitting an obstacle (in this case, a vehicle).If the measured distance is below a certain threshold, it indicates the presence of a vehicle in the parking space.

Data Processing-The Arduino board receives input signals from all the sensors installed in the parking lot.It processes this data to determine the occupancy status of each parking space. Arduino then updates the system's database or memory with real-time information about which parking spaces are vacant and which are occupied.

User Interface Interaction- LED displays or indicators placed at the entrance of each parking lane visually communicate the availability of parking spaces to drivers. Green lights typically indicate vacant spaces, while red lights indicate occupied spaces. Additionally, an LCD display may be integrated into the system to provide more detailed information, such as the total number of available parking spaces and directions to the nearest vacant spot.

Alerts and Notifications- The system can also be programmed to send alerts or notifications to parking attendants or authorities in case of any issues, such as unauthorized parking or equipment malfunction.

Maintenance and Optimization- Regular maintenance and calibration of sensors are essential to ensure accurate detection of vehicle presence.Data collected by the system can be analyzed to optimize parking lot layout, improve traffic flow, and identify trends or patterns in parking behavior.

NOTE-
Overall, the smart parking system using Arduino streamlines the parking experience for users, reduces congestion, optimizes space utilization, and enhances operational efficiency through real-time monitoring and data-driven decision-making.

3. DIFFERENT ARRANGEMENTS OF SMART PARKING SYSTEM:

Smart parking systems can be implemented in various arrangements depending on factors such as the size and layout of the parking area, the technology used, and the specific requirements of the application. Here are several different arrangements of smart parking systems:

Single-Level Parking Lot:

- In a single-level parking lot, smart parking sensors are typically installed above each parking space to detect the presence of vehicles.
- LED indicators or displays at the entrance of each parking lane communicate the availability of parking spaces to drivers.
- Data from sensors is processed by a central control unit (such as an Arduino board), which updates the status of each parking space in real-time.

Multi-Level Parking Garage:

- Multi-level parking garages require a more sophisticated system due to the vertical arrangement of parking spaces.
- Smart parking sensors are installed on each level to detect occupancy, and LED displays or indicators are placed at key points throughout the garage to guide drivers to available spaces on each level.
- In addition to vertical indicators, digital signage or navigation systems may be used to direct drivers to specific parking spots within the garage.

Street Parking:

- In urban areas with street parking, smart parking systems can be deployed along the roadside to monitor parking space availability.
- Sensors embedded in the pavement or attached to street lamps detect the presence of vehicles, and this information is relayed to a centralized control system.
- Drivers can access real-time parking availability data through mobile apps or digital signage, helping them find parking more efficiently and reducing traffic congestion.

Mixed-Use Developments:

- Mixed-use developments often feature a combination of parking structures, surface lots, and on-street parking.
- Smart parking systems in these environments may integrate various technologies, including sensors, cameras, and license plate recognition systems, to monitor parking availability across different areas.
- Centralized management software aggregates data from multiple sources to provide comprehensive parking guidance and management capabilities.

Residential Communities:

- In residential communities or apartment complexes, smart parking systems can help residents and visitors find available parking spaces more easily.
- Parking sensors installed in designated parking areas detect occupancy, and LED displays or mobile apps provide real-time information on parking availability.
- Some systems may include features such as reserved parking for residents, guest parking management, and vehicle tracking for security purposes.

Mixed-Mode Transportation Hubs:

- Transportation hubs that integrate parking facilities with other modes of transportation (such as train stations or airports) require smart parking systems that can handle high volumes of vehicles and passengers.
- These systems often include advanced features such as automated payment systems, dynamic pricing based on demand, and integration with public transit

schedules to facilitate seamless multimodal journeys.

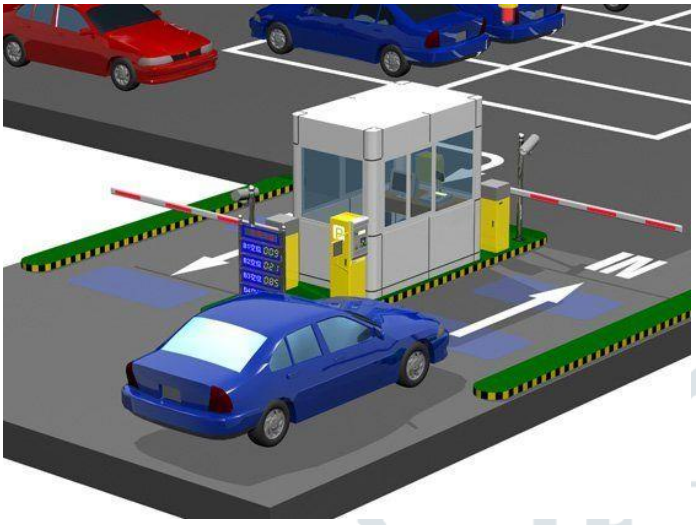

Fig: 3.1 smart car parking system.**BASIC COMPONENTS OF SMART PARKING SYSTEM :**

A smart parking system typically consists of several key components working together to efficiently manage parking spaces and provide a seamless experience for users. Here are the main components of a smart parking system:

- Parking Sensors:

Parking sensors are devices that detect the presence or absence of vehicles in parking spaces. Common types of parking sensors include ultrasonic sensors, infrared sensors, magnetic sensors, and camera-based sensors.These sensors are typically installed above or within each parking space to monitor occupancy in real-time.

- Communication Network:

A communication network facilitates the transfer of data between parking sensors, control units, and user interfaces.This network can be wired or wireless, depending on the specific implementation of the smart parking system.Wireless technologies such as Wi-Fi, Bluetooth, LoRa, or cellular networks are often used to enable connectivity between components.

- Control Unit:

The control unit serves as the central processing hub of the smart parking system.It receives data from parking sensors, processes it to determine parking availability, and controls other system components accordingly. Microcontroller platforms like Arduino or Raspberry Pi are commonly used as control units in smart parking systems.

- User Interface:

The user interface provides a way for drivers to interact with the smart parking system and access parking-related information.This can include LED displays, digital signage, mobile apps, web portals, or kiosks located at entry/exit points or accessible remotely.The user interface typically displays real-time information about parking availability, directions to available spaces, and payment options.

- Database or Cloud Storage:

A database or cloud storage system is used to store and manage parking-related data, such as parking space occupancy status, user profiles, transaction records, and historical usage patterns.This data is accessed and updated by various system components to support parking management, analytics, and reporting functions.

- Payment System:

For paid parking facilities, a payment system is integrated into the smart parking system to facilitate transactions and revenue collection.Payment options may include cash, credit/debit cards, mobile payments, or prepaid parking passes.Automated payment kiosks, mobile apps, or online payment portals are commonly used interfaces for users to pay for parking.

- Security and Surveillance:

Security and surveillance components such as CCTV cameras, motion sensors, and access control systems help ensure the safety and security of parking facilities.These components may be integrated into the smart parking system to monitor for unauthorized access, deter theft or vandalism, and provide evidence in case of incidents.

- Integration with External Systems:

Smart parking systems may also integrate with external systems or services to enhance functionality and interoperability.This could include integration with transportation management systems, navigation apps, vehicle tracking systems, or environmental sensors for air quality monitoring.

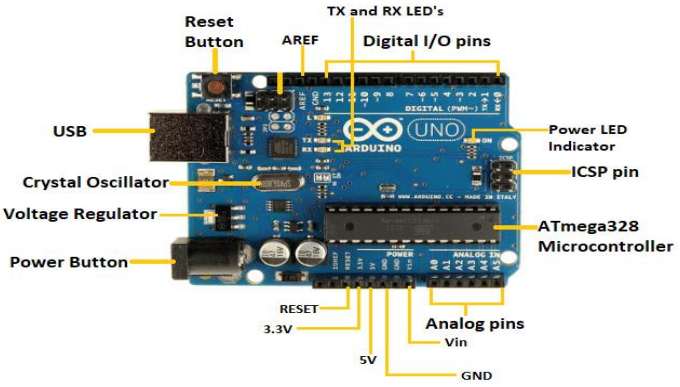

Figure 4.1: Arduino

NOTE-

By combining these components, smart parking systems can optimize parking space utilization, reduce congestion, improve user experience, and enhance overall efficiency in parking operations.

The concept of ardunio dependent on the availability of components, cost, reliability, implementation, professional technical skills required, safety requirements and most importantly its need by the customers. Therefore, studying the alternatives, in terms of all essential design steps in order to select the best one, requires right decision making. Then testing the selected option against several factors such as customer preferences and needs, national standards if it shall be recommended by government law, availability of material,

estimated material costs, financial budget, feasibility as well as efficiency of which all will determine the final selection of the design.

How the Arduino connected with others devices: It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs

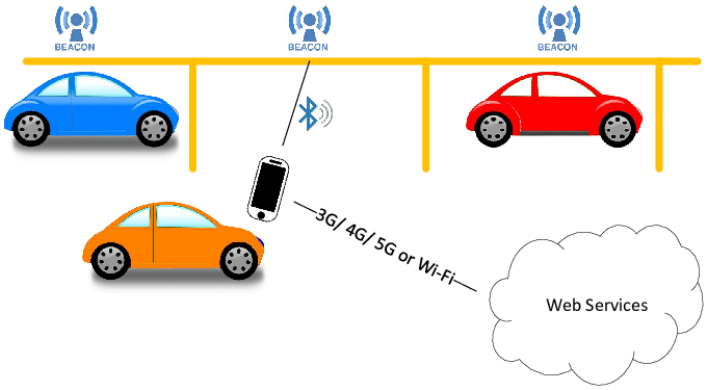

Figure 4.2 Use of Web Services in Smart Parking System

Figure 4.3 Working of Smart Parking System

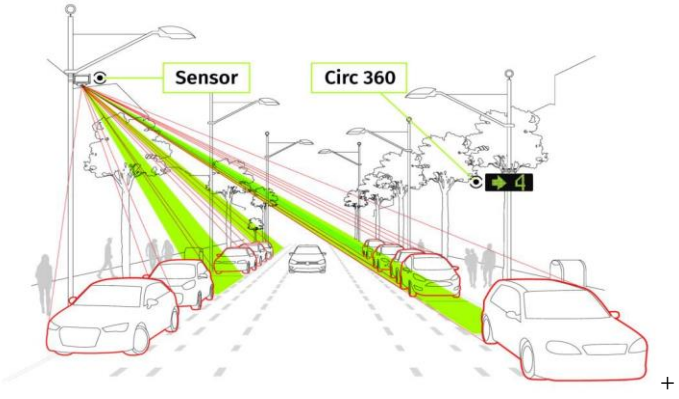

Figure 4.4 Use Of Sensors in Smart Parking System.

4. WORKING OF SMART PARKING SYSTEM.

The working concept of this involves 4 components: IR Sensor, Arduino board, Servo motors, and the LCD Display.The IR sensors are continuously scanning both sides of the crossing for cars so they can give an alert when the car is either coming or leaving. As soon as the car approaches a crossing from either side the command is sent to the Arduino board.The Arduino board upon receiving the command gives out the signal to the servo to open the crossing.The Arduino then gives out the command to LCD Display to either increase or decrease the number of empty spaces.The whole process gets started again. This completes the working concept of this project

Basic components of a smart parking system

1. Infrared Sensor
2. LCD Display
3. Servo Motor
4. Arduino
5. USB Connector
6. Arduino Controller Chip
7. NODE MCU

5. APPLICATIONS

Smart Parking System uses RFID & Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs:

- ✓ Sensor Based Detection
- ✓ Real-Time Data Collection
- ✓ Processing And Analysis
- ✓ Communication Systems
- ✓ User-Friendly Applications
- ✓ Efficient Space Utilization.
- ✓ Reduced Traffic Congestion:
- ✓ Improved User Experience

1. The system helps optimize parking space usage by guiding drivers to available parking spots, reducing congestion, and saving time.
2. to create a more connected and efficient urban environment.
3. The system can collect data on parking space utilization, which can be analyzed to improve parking infrastructure planning and management .
4. Drivers benefit from a more convenient parking experience, as they can easily find parking spots without having to search extensively.

IMPORTANT

The Smart Parking System offers a range of benefits that can improve urban mobility, reduce environmental impact, and enhance the overall quality of life in cities.

6. BENEFITS:

Improved Efficiency: By guiding drivers to available parking spaces, the system reduces the time spent searching for parking, thereby improving overall traffic flow and reducing congestion.

Enhanced User Experience: Drivers benefit from a more convenient and hassle-free parking experience, leading to higher satisfaction levels.

Optimized Space Utilization: The system enables better utilization of parking spaces by providing accurate information on occupancy status, thereby maximizing the capacity of the parking lot.

7. RESULT

The Internet of Things (IoT) is connecting devices and systems like never before, and parking is no exception. Smart sensors embedded in parking spaces communicate real-time data to a centralized system. Drivers can access this information through mobile apps, guiding them to available spots. This not only reduces the time spent circling for parking but also improves overall traffic flow in congested areas. Automated parking systems are likely to integrate seamlessly with smart city initiatives. This involves utilizing IoT (Internet of Things) sensors and connectivity to enhance overall urban mobility, reduce traffic congestion, and improve transportation efficiency.

8. CONCLUSION

In conclusion, smart parking systems represent a significant advancement in urban infrastructure, offering numerous benefits for both drivers and parking facility operators. By leveraging advanced technologies such as sensors, communication networks, and data analytics, these systems streamline the parking experience, optimize space utilization, and enhance overall efficiency.With real-time monitoring of parking space availability and user-friendly interfaces, smart parking systems help drivers quickly locate vacant spots, reducing the time spent searching for parking and alleviating traffic congestion. Additionally, features such as automated payment systems and integration with navigation apps further enhance convenience for users.

For parking facility operators, smart parking systems provide valuable insights into parking demand, usage patterns, and revenue generation. By analyzing data collected by the system, operators can make informed decisions to improve operational efficiency, optimize pricing strategies, and enhance overall management of parking facilities. Furthermore, smart parking systems contribute to sustainability efforts by reducing vehicle emissions associated with circling for parking and minimizing the environmental impact of parking facilities through better space utilization.

In summary, smart parking systems represent a key innovation in urban mobility, offering a holistic solution to the challenges of parking management in modern cities. As technology continues to evolve, these systems are expected to play an increasingly important role in shaping the future of transportation and urban development.

9. REFRENCES

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